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TABLE OF THE FAMILIES OF DIPTERA.

BY PROF. S. W. WILLISTON.

The following dichotomous table for the determination of the families of diptera has been prepared in response to the requests of a number of correspondents who desired some ready means of separating and classifying their material. It is intended for the assistance of the general entomologist or beginner in dipterology more especially, and is in no wise a classificatory exposition of the subject, except in so far as it separates families.

The beginner will be much aided by having at his command a small collection of determined specimens, together with a considerable material for comparison. Difficulties to the inexperienced will often disappear with positive evidence before him, where negative characters may be puzzling. In lieu of such material, or even with it, the few following directions will be of assistance.

Let him select for comparison a common large horsefly (*Tabanidæ*) and a common house or bluebottle-fly (*Muscidæ*). By comparing the tip of the tarsi (feet) in the two, he will immediately observe what is meant by the expression, "Empodia developed pulvilliform." The middle membraneous appendage on the under side of the claws in the horsefly is the pulvilliform empodium, while in the housefly the two outer ones, the pulvilli, alone are present. The tarsus, composed of five joints, the tibia, the femur, and the coxa, attaching the leg to the thorax, will be readily understood.

The antennæ of the housefly will show what is meant by three simple joints, the third of which bears the dorsal arista. The third joint in the horsefly, on the other hand, will be seen to be "complex," that is, composed of a number of closely united segments; it is also without style or bristle. The three, small, simple eyes (*ocelli*) will be seen at the vertex in the housefly. The tegulæ are flattened membraneous scales, one overlapping the other, just back of the root of the wings, and covered over by them; they are well developed in both flies.

To understand the neuration, observe in the horsefly, near the middle of the wing directed transversely, a large, oblong, five or six-sided cell, surrounded on all sides by other cells. This is the discal cell, and is present in the majority of flies. In nearly all cases, somewhere on the vein (fourth longitudinal) that bounds this cell in front, will be seen a short connecting vein, directed anteriorly; this is the anterior or small cross-vein, and affords, in most cases, a key to the neuration, no matter how intricate. It always connects the fourth longitudinal vein behind with the third longitudinal in front; the cell behind it is the discal, in front the submarginal, on the outer side the first posterior, on the inner side the first basal. Lying parallel with the first basal cell, and just behind it, is the second basal cell; just behind the second basal cell is the third basal or anal cell. In the horsefly, the anal cell is seen to run back obliquely to near the posterior margin of the wing, where it terminates acutely, that is, the anal cell is said to be closed near the border of the wing; should the two veins that close it run separately into the wing's margin, then the cell is open. Now, counting outwardly along the posterior border to the third longitudinal vein (posterior branch), there will be seen five posterior cells, all open (except in a few species of our *Tabanidæ* the first posterior cell is closed), with their bases bordering on the discal and first and second basal cells. By following the third longitudinal vein outwardly from the anterior cross-vein, it is seen to give off an anterior branch, which runs to terminate in the front margin or costa of the wing; the third longitudinal vein is here furcate, and two submarginal cells are present. Compare now these same structures in the housefly, and the discal cell is found much more elongated, the basal and anal cells small, the third longitudinal vein simple, not furcated, and only one submarginal and three posterior cells are present. Do not confound the obliquely placed vein that nearly closes the first posterior cell with the furcation of the third vein. The housefly will also show clearly the six longitudinal veins, the last of which runs obliquely backward from the anal cell toward the margin, the fifth bordering the discal cell behind, the first and second running into the costa. The first vein that terminates in the costa (before the middle of the wing) is the auxiliary. The vein that closes the discal cell outwardly is the posterior or great cross-vein; the one that closes the anal cell outwardly, the posterior basal cross-vein.

The above will indicate the leading principles of the neuration and structure peculiar to flies. For further information, the reader is referred to the system of terminology given by Loew in the first volume of the Monographs of North American Diptera, a system which, upon the whole, I believe to be superior to any other now in use.

The numerous sub-families of the *Muscidæ acalyptratæ* are omitted; I am not able to include them satisfactorily.

TABLE FOR THE DETERMINATION OF THE FAMILIES OF DIPTERA.

1. Flies of a leathery or horny structure, living parasitically in the adult state upon warm-blooded vertebrates or bees; head small, either closely united to the emarginate anterior part of the thorax, or folding back into a groove upon the dorsum; mouth-parts incomplete, the palpi wanting; legs separated by the broad sternum; abdomen indistinctly segmentated; claws well developed.. 49

Flies of softer structure, never living parasitically in the adult state upon warm-blooded vertebrates; head separated from thorax by a free neck.......... 2

2. Antennæ many-jointed, often longer than the thorax, the two basal joints, only, differentiated, the remaining joints usually distinct; palpi composed of from three to five joints, usually elongate; anal cell never closed or narrowed at the margin*. (*Nematocera.*)... 3

Antennæ rarely as long as the thorax, composed primarily of three joints, the third of which may be simple or complex, (that is, composed of more or less distinct annuli or segments,) with or without a terminal or dorsal arista or style; anal cell closed before the border, or distinctly narrowed in the border, or, if of other structure, the antennæ composed of three simple joints; palpi rarely much elongate, composed of from one to three joints............. 12

3. Dorsum of thorax with a distinct V-shaped suture†; wings (wanting in *Chionea*) many-veined, often with a complete discal cell; ocelli wanting (present in *Trichocera*); often large flies.......................................TIPULIDÆ

Dorsum of thorax without a V-shaped suture, or rarely with any transverse suture (*Blepharoceridæ*).. 4

4. A complete discal cell present; ocelli present; empodia developed pulvilliform, pulvilli rudimentary..RHYPHIDÆ

No discal cell.. 5

**Plecia*, and perhaps some others, may be exceptions.

†*Bittacomorpha*, *Ptychoptera*, and *Idioplasta* will alone cause doubt here. They have the suture incompletely V-shaped and sinuous. The last will be distinguished from *Rhyphidæ* chiefly by the absence of ocelli; the two former will be separated from the *Culicidæ* by the absence of hair on the veins, their larger size, and in *Bittacomorpha* by the peculiar clubbed tibiæ.

5. Wings with only a few longitudinal veins, and no cross-veins; coxæ not elongate, tibiæ without terminal spurs, legs not thickened; ocelli present or absent; small or minute, delicate, mostly gall-producing flies.......... CECIDOMYIDÆ

Not such flies, wings usually many-veined.................................. 6

6. Ocelli present.. 7

Ocelli wanting (compare *Mycetophilidæ*).. 9

7. Wings broad, bare, characteristically marked by numerous folds between the veins, giving a netted, spiderweb-like appearance.......... BLEPHAROCERIDÆ

Wings not so marked; no entire transverse suture........................ 8

8. Coxæ much elongated (moderately so in *Sciarinæ*); antennæ often elongate, the joints constricted; three or two ocelli (in the latter case situated near the eyes, and often hardly perceptible); all the tibiæ with spurs...... MYCETOPHILIDÆ

Coxæ short, the thorax rounded, not humped, above; antennæ shorter than the thorax, thickened, the joints closely united without marked constrictions; legs strong, the front femora often thickened; empodia pulvilliform, the pulvilli sometimes absent; eyes of male large...................... BIBIONIDÆ

9. The costal or marginal vein does not extend beyond tip of the wing........ 10

The marginal vein encompasses the entire wing........................ 11

10. Antennæ slender, the joints more or less constricted, and often bushy plumose; legs slender, hind tibiæ and metatarsi never dilated; body and abdomen slender; wings narrow... CHIRONOMIDÆ

Antennæ shorter than the thorax, the joints broadly and closely united, without marked constrictions, and never hairy or pilose; legs strong, hind pair more or less dilated; body thick-set, abdomen ovate; wings broad, bare, the anterior veins stouter, the posterior ones weak. Black flies, buffalo gnats.. SIMULIDÆ

11. Wings distally, with ten longitudinal veins, without cross-veins, broad, pointed, veins strongly hairy; tibiæ without terminal spurs; small, lepidoptera-like flies, the wings when at rest, folded roof-shaped .... PSYCHODIDÆ

Wings with small cross-veins near the middle, not broad and pointed, the veins hairy and conspicuously fringed along the hind margin; wings when at rest not roof-shaped. Mosquitoes.................................... CULICIDÆ

12. Third joint of the antennæ complex; basal cells of wing long.............. 13

Antennæ composed of three simple joints, the third not annulated or segmentated, with or without a dorsal arista, or terminal style or arista........... 19

13. Empodia undeveloped or bristle-like; antennæ elongate, composed of four or five joints, without differentiated style or arista; vertex and front hollowed out transversely between the eyes; eyes of male never contiguous........ 25

Empodia developed pulvilliform; third antennal joint more or less distinctly segmentated or annulated... 14

14. Tegulæ rather large; third longitudinal vein furcate; five posterior cells always present; the costal vein encompasses the whole margin of the wing; proboscis of the female adapted for piercing; third joint of antennæ with from three to eight annuli, never with style or bristle. Horseflies .... TABANIDÆ

Tegulæ small or rudimentary; mostly flower-flies........................ 15

15. Tibiæ wholly without terminal spurs.................................... 16

The middle tibiæ at least, with distinct spurs; the costal vein encompasses the entire wing; third longitudinal vein always furcate, and five posterior cells always present... 17

16. Longitudinal veins of the wings usually crowded anteriorly, those posteriorly often weak; the costal vein does not reach beyond the tip of the wing; antennæ long or short, with or without a terminal or dorsal arista or style. STRATIOMYIDÆ
    Longitudinal veins not crowded anteriorly; the marginal vein encompasses the entire wing; third longitudinal vein always furcate, and five posterior cells always present; third joint of antennæ never with style or bristle........ 17

17. All the tibiæ with spurs; third joint of antennæ sometimes divided into separate joints...XYLOPHAGIDÆ
    Front tibiæ without spurs... 18

18. Fourth posterior cell of wings closed (*Subula})...............STRATIOMYIDÆ, *pt.*
    Fourth posterior cell open (*Arthrocerinæ*)........................LEPTIDÆ, *pt.*

19. Antennæ apparently single-jointed, with a long bristle; wings with several stout veins anteriorly, and other weaker ones running across the surface unconnected by cross-veins; femora flattened; the hind legs long; antennæ situated near the mouth; small, quick-running, hunchback-like flies.........PHORIDÆ
    Not such flies.. 20

20. Empodia developed pulvilliform, that is, three nearly equal, membraneous appendages on the under side of the claws.................................. 21
    Empodia wanting, rudimentary or linear, not developed like the pulvilli.... 23

21. Tegulæ very large, inflated; thorax and abdomen inflated; head small, eyes very large; neuration varied..CYRTIDÆ
    Tegulæ of moderate size or rudimentary.................................. 22

22. Middle tibiæ, at least, with spurs, no bristles on femora or tibiæ; third longitudinal vein furcate; five posterior cells present (four in *Agnotomyia*); anterior cross-vein always distinct; third joint of the antennæ with a bristle or slender style, usually terminal...LEPTIDÆ
    Not such flies.. 23

23. Third longitudinal vein of the wing simple, not furcate.................... 32
    Third longitudinal vein furcate, two or more submarginal cells present...... 24

24. Arista or style of antennæ, when present, always terminal.................. 25
    Arista dorsal, always present.. 37

25. Vertex and front distinctly hollowed out transversely between the eyes; eyes of male never contiguous; basal cells large; mostly large flies.............. 26
    Front and vertex plane or convex; eyes of male often contiguous.......... 27

26. Proboscis without fleshy labellæ at the tip, the under part forming a horny sheath; the posterior branch of the third vein terminates behind the tip of the wing; five posterior cells always present; predaceous flies.......ASILIDÆ
    Proboscis with fleshy labellæ at the tip; neuration complicated, the third vein, at least, curves forward to terminate before the tip of the wing; antennæ with a terminal flattened lamella...................................MIDAIDÆ

27. Five posterior cells in the wing; basal cells large......................... 30
    Never more than four posterior cells in the wing......................... 28

28. Third antennal joint without bristle or style; three posterior cells; first posterior cell narrowed or closed, the fourth longitudinal vein terminating at or before the tip of the wing...SCENOPINIDÆ

Third antennal joint rarely without terminal style; four or three posterior cells; the fourth vein terminates beyond the tip of the wing.................. 29

29. Anal cell narrowly open, or closed near the border................Bombylidæ

Anal cell closed, remote from the border..............................Empidæ

30. Neuration intricate, the small cross-vein wanting or rudimentary, owing to the coalescence of the third and fourth veins for a longer or shorter distance; tibiæ without terminal spurs; empodia and pulvilli membraneous, but frequently minute..Nemistrinidæ

Neuration not intricate; the anterior cross-vein always distinct; labellæ of proboscis fleshy.. 31

31. The posterior branch of the third vein terminates before the tip of the wing; male sexual organs prominent..................................Apioceridæ

The posterior branch of the third vein terminates behind the tip of the wing; male sexual organs small......................................Therevidæ

32. Antennæ with a dorsal arista... 38

Antennæ with a terminal arista or style................................ 33

33. Wings pointed, no cross-veins in the middle, the fourth longitudinal furcate and united with the fifth; small species..........................Lonchopteridæ

Wings rounded at the tip, not lancet-like.............................. 34

34. Second basal cell confluent with the discal cell, not separated by a small vein; the auxiliary vein does not terminate in the costa; small, mostly brilliant-colored, predaceous flies....................................Dolichopodidæ

Second basal cell separated from discal cell by a small vein................ 35

35. Antennæ with a terminal style... 36

Antennæ with a terminal bristle... 37

36. First posterior closed (*Conopidæ*, pt., *Syrphidæ*, pt.)...................... 41

First posterior cell open..Empidæ

37. Head comparatively small; the proboscis usually more or less elongated; alulæ of wing usually rudimentary......................................Empidæ

Head as broad as the thorax; proboscis fleshy; alulæ distinct.....Platypezidæ

38. Proboscis rudimentary, palpi wanting: first posterior cell usually narrowed; tegulæ usually large. Botflies..................................Œstridæ

Proboscis not rudimentary; palpi present.............................. 39

39. Second basal cell confluent with the discal cell; not separated by a small vein; small, mostly brilliant-colored, predaceous flies; face never broad and convex. Dolichopodidæ

Second basal cell separated from the discal cell by a small cross-vein (or, if not, not brilliant-colored, predaceous flies, and the face always broad and arched, *Ephydrinæ*)... 40

40. Posterior basal cells of wing elongate; the anal cell closed toward the margin; first posterior cell closed or much narrowed (except sometimes in *Pipunculidæ*)... 41

Posterior basal cells of wings small; the anal cell always closed remote from the margin.. 43

41. Face with sub-antennal vertical grooves or depression. (*Conopidæ*, pt.)..... 43

Face convex transversely, or with a median ridge; never with a sub-antennal depression.. 42

42. Between the third and fourth longitudinal veins, and sub-parallel with them, crossing the anterior cross-vein, a spurious longitudinal vein, or, when rarely not present, the first posterior cell closed a considerable distance from the border; eyes never extraordinarily large; abdomen never with bristle. SYRPHIDÆ

Spurious vein never present; first posterior cell never closed before the margin; eyes very large, including the largest part of the head; small species. PIPUNCULIDÆ

43. Proboscis horny, elongate, often folding back near the middle; abdomen never with bristles; tibiæ without terminal spurs (or, if with them, the face with a median ridge, and the proboscis folding); first posterior cell closed or narrowed...CONOPIDÆ

Proboscis fleshy and not elongate, (or if elongate and slender, with or without a median hinge, the abdomen with distinct bristles, or the antennæ plumose)..44

44. Tegulæ large; face with sub-antennal vertical grooves or depression. (*Muscidæ calyptratæ*)... 45

Tegulæ small.......................................MUSCIDÆ ACALYPTRATÆ

45. First posterior cell widely open, not narrowed in the margin.....ANTHYOMYIDÆ

First posterior cell closed, or more or less narrowed...................... 46

46. Antennal arista wholly bare.......................................TACHINIDÆ

Antennal arista distinctly pubescent or plumose......................... 47

47. Arista bare on the distal part; dorsum of abdomen rarely bristly before the distal part...SARCOPHAGIDÆ.

Arista plumose or pubescent to the tip.................................. 48

48. Dorsum of abdomen bristly; legs usually elongate.....................DEXIDÆ

Abdominal segments without bristles, except sometimes somewhat near the tip. MUSCIDÆ

49. Wingless flies, parasitic upon bats; head not flattened, folding back upon the dorsum of the thorax; first joint of tarsi not abbreviated.......NYCTERIBIDÆ

Winged or wingless flies, parasitic upon birds, quadrupeds, or bees; head flattened, sunk into a shallow emargination of the thorax; first joint of the four anterior, or all, tarsi abbreviated............................HIPPOBOSCIDÆ

For the determination of the genera and species, a large number of papers must be consulted, a list of which would be out of place here, and which, up to 1878, will be found in Osten Sacken's Catalogue (Smithsonian, 1878), a work whose necessity will be first to the student. Papers published since that time on North American Diptera have been by the following authors: C. R. v. Osten Sacken, F. M. v. d. Wulp, F. Brauer, V. v. Roeder, J. Mik, J. F. M. Bigot, F. A. F. Karsch, E. Burgess, D. W. Coquillett, and the writer. The following list only, containing such papers as present tables or descriptions of the North America genera, in the families named, may be given:

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MUSCIDÆ ACALYPTRATÆ (*Ortalidæ*, *Trypetidæ*, *Sciomyzidæ*, *Ephydridæ*). Loew, Monographs, etc., i, iii, Smithsonian, 1862, 1873.

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NOTE ON A REMARKABLE FOSSIL.

BY ROBERT HAY, JUNCTION CITY, KAS.

Some time ago, on Sand creek, in Woodson county, a farmer's plow turned up what might be called a fine concretion in a district where concretions are plentiful. It was an oblate spheroid, very nearly a sphere, made of the hard clayey ironstone, so common in that region in the form of nodules. Its smallest circumference is 9 inches, its greatest circumference 9½ inches. Being so nearly a sphere, it was a boy's toy for six months, when a spirit of investigation being upon him, he broke it with an ax and showed the internal structure. It appeared to the boy and his friends to be a perfectly petrified walnut. The fracture made two concave hemispheres, out of which dropped the round nut broken into several pieces, showing internal septa. A few small fragments were lost, but the rest then fell into the hands of J. B. Stockton, of Toronto, by whose kindness the writer is permitted to submit it to the Academy. The outside portion of this petrifaction, to the thickness of five-sixteenths of an inch, is undoubtedly concretionary matter. Within that and closely adherent to it is another layer, that seems as certainly to be of organic origin. This layer is three-sixteenths thick, and seems of a fibrous structure like the outer rind of a walnut or hickory nut. The concave surface of this layer is irregularly marked with hard brown lines, which stand in slight relief from the rest, which is softer and yellowish in color. The spaces between the lines are wider near the poles of the sphere. This envelope shows no signs of segments in any direction. The outside surface of the included nut is marked by lines and spaces corresponding to those on the concavity of its envelope, but giving a much smoother surface, being somewhat smoother than the corresponding surface of an English walnut. This shell appears to be divided into three layers, having a total thickness of one-eighth of an inch, and a fourth layer another eighth, which sends off the septa across the nut. The principal septum is double. The internal cavities are hollow, having probably been filled, before the nut was broken, with some softer material, as dust or sand. The longest diameter — transverse to the septum — is one inch and five-eighths; the shortest, one inch and